Chapter 3: The Effect of Local Restrictions on Restaurant Smoking on Residents' Exposure to Environmental Tobacco Smoke

In this chapter logistic regression analysis is used to determine whether local restaurant smoking ordinances reduce the likelihood that people will be exposed to environmental tobacco smoke (ETS) when they dine out. Controlling for demographic characteristics and time trends, ordinances both in a resident's home town and ordinances elsewhere in the state are shown to have statistically significant negative effects on the likelihood of reported exposure. The analysis is based on data from the Massachusetts Adult Tobacco Survey (MATS) and the Massachusetts Tobacco Control Program Ordinance Tracking System (MTCP-OTS).

Background

Environmental tobacco smoke is known to have adverse health effects on non-smokers who are subjected to exposure. ETS contains thousands of chemicals including 43 known carcinogens. The known health impacts from exposure to ETS include lung cancer, nasal sinus cancer, and heart disease in non-smoking adults, as well as developmental and childhood disorders sudden infant death syndrome, bronchitis, and heart disease.[1,2] The California Environmental Protection Agency estimates that each year in the United States, ETS causes up to 3,000 deaths due to lung cancer, up to 62,000 deaths due to ischemic heart disease, and up to 2,700 deaths due to sudden infant death syndrome. In infants and children ETS is responsible for 9,700 to 18,600 cases per year of low birth weight infants, 8,000 to 26,000 new cases per annum of asthma in children, and 150,000 to 300,000 cases per year of bronchitis or pneumonia in children under 18 months.[3]

ETS can also cause irritation of the eyes, nose and throat, which results in redness, itching, swelling, coughing and sore throat.[4] The discomfort experienced by non-smokers from ETS exposure is well documented in analyses focusing on occupational health hazards resulting from exposure to tobacco smoke in the workplace. A survey of restaurant and bar workers in Wellington, New Zealand found that over half the staff exposed to tobacco smoke at work reported throat or lung irritation caused by ETS.[5]

Studies show that few people are actually able to avoid exposure to ETS and up to 80 percent of non-smokers are susceptible to ETS exposure on a daily basis, in workplaces and public areas where smoking is not restricted, such as restaurants and bars.[6] A real time measurement of indoor particulate matter resulting from ETS found that it adds to indoor particulate pollution, causing particulate matter concentrations to exceed air quality standards.[7]

Concentrations of ETS are particularly problematic in restaurants where smoking is permitted. Studies show that regular patrons and restaurant workers are disproportionately affected by exposure to ETS.[8] Even with restrictions that limit smoking to certain areas within the restaurant, patrons may not have complete protection against exposure. An investigation into ETS concentrations in non-smoking sections of restaurants found mean concentrations of respirable suspended particles and nicotine in non-smoking areas amounting to 60 percent and 35 percent, respectively, of the levels in smoking areas.[9] In a meta-analysis, Siegel found that ETS levels in restaurants were 1.6-2.0 times higher than in other workplace and business environments and 1.5 times higher than in home environments with at least one smoker.[10]

Support for smoke free restaurants has been growing in Massachusetts and around the country over the past two decades. In a Massachusetts telephone survey of 4929 adults in 1995-1996, nearly half of all adults reported avoiding restaurants and bars because of the expectation of excessive ETS.[11] Analyses from the Massachusetts Behavioral Risk Factor Surveillance System showed that between 1992 and 1999 the rate of support for smoke free restaurant increased from 37.5 percent to 59.8 percent among smokers and non-smokers.[12] Results from the California Adult Tobacco Survey show that 87.7 percent of Californians prefer to eat in smoke free restaurants.[13]

This growing social preference for clean indoor air is demonstrated by the increasing number of state and local governments that have enacted legislation to restrict or completely ban smoking in restaurants. The Center for Disease Control's Office on Smoking and Health reports that as of the fourth quarter in calendar year 2001, 31 states had enacted smoke free indoor air restrictions in restaurants. Of these, two states had a complete ban and one had designated areas with separate ventilation.[14]

In Massachusetts the enactment of policies restricting exposure to ETS has occurred primarily at the town level. Over the period of the MTCP, the state has seen rapid growth in the number of towns that have adopted ordinances restricting indoor smoking in public places. Local boards of health funded by the MTCP are charged with assessing the need for tobacco control policies and supporting their enactment. Research has shown that receiving MTCP funding increases a town's probability of adopting tobacco control ordinances or regulations in general, and restrictions on restaurant smoking

in particular.[15,16] Massachusetts town ordinance adoption trends are very closely aligned with funding patterns. Of the funded towns, 54.3 percent have a restaurant ordinance in effect, compared with 10.5 percent of non-funded towns. By June 2001, 182 towns representing 78 percent of the Massachusetts population had enacted restaurant ordinances.[17] The majority of these were enacted after 1993 following the implementation of the MTCP.

Despite widespread adoption of restaurant smoking restrictions, little is known about the extent to which the restrictions actually reduce overall population exposure to ETS. A smoking restriction might not lead to reduced exposure for several reasons. Policies vary substantially in the severity of the restriction, from minimal requirements for non-smoking areas to complete smoking bans, and even stringent ordinances may not be enforced effectively. Restaurants, especially chain restaurants, may have voluntary smoking restrictions even without a local policy. Moreover, consumers might respond to changes in restaurants' practices by changing their pattern of patronage, which could either increase or reduce the impact of the restrictions. Nonetheless, the only research to date has focused on workers: a study of self-reported exposure to ETS among bartenders over a period of time in which the smoking policy changed from non-restrictive to restrictive found that self-reported ETS exposure declined after the implementation of a smoking ban from a median of 28 hours a week to two hours a week.[18] No studies to date have examined the effects for patrons or the population at large.

The analysis reported here addresses the question of how the adoption of local ordinances restricting smoking in restaurants has affected self-reported ETS exposure by Massachusetts residents. We look at the effect of ordinances adopted in the individual's home town and the effect of ordinance adoption in other towns in the state.

We also consider the possibility that MTCP funding of local boards of health might have an effect on ETS exposure in restaurants, independent of the effect of increasing the likelihood of ordinance adoption. Such an effect might occur if, for example, the local board raises citizens' awareness of the dangers of environmental tobacco smoke, leading them to patronize smoke-free restaurants as well as to support passage of an ordinance.

Data Sources and Methods

Survey data from the Massachusetts Adult Tobacco Survey (MATS) were used in combination with data on ordinances for the 351 towns taken from the Massachusetts Tobacco Control Program Ordinance Tracking System (MTCP-OTS). The MATS is conducted by the Center for Survey

Research at the University of Massachusetts in Boston. The MATS survey was a random digit dial survey of stratified probability samples of the population in the state. A sample of Massachusetts residents were interviewed in each month. Data from fiscal years 1995-2000 are used in this analysis. The sample size numbers for each fiscal year are shown in Exhibit 3.1.

Exhibit 3.1
MATS Annual Sample Size

Year	Number in sample
1995	950
1996	2,792
1997	2,964
1998	2,705
1999	2,621
2000	2,939
TOTAL	**14,971**

The MTCP-OTS is a database maintained by the Massachusetts Department of Health (DPH) detailing information on tobacco-related ordinances, municipal by-laws, and regulations that have been proposed, enacted, effected and/or repealed in the state. The DPH collects the data through local boards of health and health departments that receive funding under the MTCP Board of Health program. These agencies are required to provide information on all local ordinances (a term used to include by-laws and regulations) designed to limit ETS or restrict the marketing or accessibility of tobacco products to youth. The DPH first requested these data in 1995, at which time it requested information on all provisions that had been in place at any time since 1990. Subsequent reports have been required as new locations are funded, new provisions are proposed or adopted, or existing provisions are modified or repealed. In addition, local health officials in towns not receiving MTCP funding were surveyed to obtain comparable information on those towns.

Ordinances are coded as being 'in effect' or not for each town in each time period. The ordinance data goes from July 1993-June 2000 and is aggregated into 14 six-month time periods. Any ordinance that was enacted before July 1993 is coded as being 'in effect' from the first time period. An ordinance is coded as being 'in effect' if it was in existence for at least three out of the six months of a given time period.

The dependent variable for the analysis comes from the following MATS question, which was asked only of respondents who had answered a previous question by saying that they sometimes eat in

restaurants: *"In the past three months, when you ate in restaurants, how often were you exposed to other people's tobacco smoke? Would you say…*

1. *Always*
2. *Often*
3. *Sometimes*
4. *Rarely*
5. *Never"*

A variety of individual and household factors that were hypothesized to affect a person's pattern of restaurant choices, and hence their likelihood of ETS exposure in restaurants, were included as covariates. These include demographic indicators for age, race, gender, and education level. Other factors are whether or not the respondent is a smoker, the frequency with which the respondent eats at restaurants, and whether there are children under the age of 12 in the household. In addition to the respondent-level covariates, a variable representing time (month and year) was included to account for any secular trend in ETS exposure related to general factors such as declining smoking prevalence.

The predictor variables of primary interest measure the current status of ordinances in the respondent's **home town** and the **state as a whole**. The home town measure is dichotomous, and indicates whether the town in which the respondent resided had a restaurant ordinance in effect at the time of the interview (measured as the half-year period during which the interview was conducted). The statewide measure represents the weighted percent of towns in the state that had ordinances when the interview was conducted, where the weight is the number of restaurants in the town in 2001.

The rationale for including measures of both the home town and the statewide ordinance status was that people may eat at restaurants outside their home town. Whether a person chooses a restaurant inside or outside the town would presumably depend on the number of restaurants available in town and the distance to restaurants in other towns, among other factors. We tested proxies for this factor (e.g., interaction terms using the percent of the state's restaurants in the respondent's home town) but found that parameter estimates were highly sensitive to the specification, and did not include these terms in the final specification.

We also hypothesized that the effect of ordinances, whether in the home town or elsewhere, might depend on the length of time the ordinance had been in effect. One might expect that compliance with the restrictions would increase (or perhaps decrease) over time, leading to a lagged effect. To test this hypothesis, we estimated two versions of the model. The base model included only the two terms measuring current ordinance status. The full model added two terms measuring the length of time the ordinance had been effect. For the home town, this was the natural log of the number of six-month

periods the ordinance had been in effect up to the time of the interview. For the statewide measure, the main term (weighted percentage of towns with ordinance) was further weighted by natural log of the number of time periods that the ordinance had been in effect in each town. The logarithmic specification reflects a hypothesis that the lagged effect, if any, might not be linear.

In addition to these policy variables, we included four town-level variables that have been shown in other research to be associated with the likelihood of ordinance adoption: whether the town ever received MTCP funding for its board of health; population (less than 20,000, 20,000 to 50,000, and over 50,000); percent Non-Hispanic White; and percent "yes" vote on Question 1 (the 1992 referendum that raised the tobacco excise tax and provided funding for the MTCP).

The models were estimated using SUDAAN software to account for the complex sample design of the MATS. The Multilog Procedure was used to estimate ordered logit models. This procedure supports estimation with categorical dependent variables where there may be more than two categories and where the categories may or may not be ordered. With the ordered logit model specification, the responses are distributed among the five possible categories ("always" to "never" exposed). The model estimates four separate intercepts, which demarcate the dependent variable response categories. The explanatory variable parameter estimates are consistent across the five dependent variable response categories. (Graphically the result is depicted by four curves with identical slopes and different intercepts.)

The specification for the logistic model is as follows:

$$Z_{it} = a_i + ß_{it}\ \text{Ordinances} + ß_{jt}\ \text{Ordinance*Time Effects} + ß_{kt}\ \text{MTCP Funding} + d_i\ \text{Demographics} + d_j\ \text{Other Individual Effects} + d_k\ \text{Other Town Effects} + d_l\ \text{Time} + e_{it}$$

Where:

- Z_{it} = Reported exposure
- a_i = Ordered logit intercepts
- $ß_{it}$ = Parameters for hometown and state level ordinance status
- $ß_{jt}$ = Parameters for the length of time that hometown and state level ordinances were in effect when the interview occurred
- $ß_{kt}$ = Parameter for whether the town received MTCP funding for its board of health
- d_i = Parameters for demographic variables
- d_j = Parameters for other respondent-level variables, including respondent's smoking status, presence of children and frequency of eating out
- d_k = Parameters town population, percent of population that is Non-Hispanic White, and percent of voters who voted "yes" on Question 1
- d_l = Parameters for calendar date (year and month) of the interview and number of restaurants in the respondents home town

e_{it} = Error term

The number of respondents who said they eat out in restaurants is 13,982, of whom 13,532 responded to the question about exposure. Of these, 6850 reported that they are always, sometimes or often exposed to ETS is restaurants and 6682 reported that they are rarely or never exposed. For the actual analysis 12,890 observations were used, omitting those with missing data in one or more variables.

Results

Exhibit 3.2 shows the parameter estimates and significance levels for the model. To summarize:

- **Home town ordinance status** – Respondents who lived in towns with a restaurant ordinance in effect at the time of the interview were less likely to report exposure to ETS in restaurants than respondents who lived in towns where no ordinance was in effect at the time of the interview, controlling for individual- and town-level characteristics. This effect is statistically significant in both the base model and the model including the time effects of the ordinances.

  The odds ratios for home town ordinance status are 0.83 in the base model and 0.78 in the full model. This implies that a respondent who lives in a town with a restaurant ordinance will be 25 percent more likely to report a lower rather than a higher level of exposure (e.g., to report being "sometimes" rather than "often" exposed, or "often" rather than "always").

- **Statewide ordinance status** – When ordinances cover a larger proportion of the restaurants outside the respondent's home town, respondents report less exposure to ETS, independent of whether an ordinance exists in their home town. This relationship is marginally significant in the base model and significant in the full model. The odds ratio in the full model (0.05) implies that, if all towns in the state had restaurant ordinances, respondents would be 20 times more likely to report a one-step lower level of exposure than if no towns had ordinances.

- **MTCP funding for local board of health** – Respondents in towns with MTCP funding reported significantly less exposure in both models, indicating that the towns that sought and received funding tended to have lower exposure levels.

- **Time effects of home town and statewide ordinances –** Neither time effect is statistically significant.

- **Town population** – Differences in reported exposure by size of respondent's town were not statistically significant.

- **Percent of residents who voted "yes" on Question 1** – Residents of the towns that were highly supportive of tobacco control in 1992 reported significantly lower levels of exposure.

- **Percent of town population that is Non-Hispanic White** – This variable was marginally significant in both models, implying some tendency for residents of towns with larger minority populations to report less exposure.

- **Age** – Older respondents were less likely to report ETS exposure in restaurants than younger people, with statistically significant differences between people under 25 and those aged 45 and over.

- **Race/ethnic group –** Respondents who were racial/ethnic minorities tended to report less exposure than Non-Hispanic Whites. The difference was statistically significant for Non-Hispanic Blacks, and marginally significant for Hispanics and Non-Hispanic Asians.

- **Education** – Differences in reported exposure by education level were not statistically significant.

- **Gender** – Differences in reported exposure by gender were not significant.

- **Frequency of Eating at Restaurants** – Respondents who eat at restaurants frequently were more likely to report exposure than those who eat out less often than once a month. The differences were statistically significant for those who eat out about once a week and those who eat out more frequently than once per week .

- **Children in household** – Differences in reported exposure were not significantly related to having children in the household.

- **Smoking status** – As might be expected, smokers were more likely to be exposed to ETS in restaurants than non-smokers.

- **Time** – Exposure to ETS in restaurants became less likely for Massachusetts residents over time, independent of the presence or duration of ordinances.

Exhibit 3.2
Results of the Logistic Regression Model

	Base model		Full model	
Independent variable	**Beta coefficient**	**P value**	**Beta coefficient**	**P value**
Hometown restaurant ordinance				
None in effect	Reference		Reference	
In effect	-0.183	0.015	-0.246	0.031
Statewide ordinance coverage	-1.302	0.056	-3.044	0.013
Time effect for hometown ordinance			0.423	0.118
Time effect for statewide coverage			0.038	0.553
MTCP funding	-0.409	0.034	-0.416	0.029
Population				
<20,000	Reference		Reference	
20,000-49,000	0.074	0.418	0.063	0.496
50,000+	0.181	0.143	0.179	0.152
Percent White Non-Hispanic	0.576	0.081	0.606	0.065
Percent Yes on Q1	-0.918	0.028	-0.934	0.026
Age				
18-24 years	Reference		Reference	
25-44 years	-0.297	0.011	-0.299	0.010
45-64 years	-0.506	0.000	-0.511	0.000
65+ years	-1.063	0.000	-1.066	0.000
Race				
Non-Hispanic White	Reference		Reference	
Non-Hispanic Black	-0.549	0.000	-0.544	0.001
Hispanic	-0.304	0.081	-0.310	0.075
Non-Hispanic Asian	-0.524	0.056	-0.524	0.056
Other	0.349	0.154	0.330	0.185
Education				
Less than high school degree	Reference		Reference	
High school	0.284	0.139	0.277	0.151
Some college	0.317	0.098	0.309	0.108
BA or higher	0.344	0.069	0.337	0.076
Gender				
Male	Reference		Reference	
Female	-0.001	0.988	0.001	0.989
Smoking status				
Non-smoker	Reference		Reference	
Smoker	0.514	0.000	0.508	0.000
Frequency of eating out				
More than once a week	0.459	0.001	0.464	0.000
Once a week	0.367	0.004	0.374	0.003
Once or twice a month	0.123	0.333	0.127	0.316
Less than once a month	Reference		Reference	
Chileren in Household				
None under age 12	Reference		Reference	
One or more	-0.117	0.139	-0.119	0.134
Calendar time	-0.011	0.000	-0.012	0.000
-2 * Normalized log-likelihood		36153		36139
Approximate chi-square		1114		1128

Discussion

The findings support the hypothesis that implementing local policies restricting smoking in restaurants leads to lower levels of perceived ETS exposure for restaurant patrons. Statistically significant effects are found for the presence of a restaurant ordinance in the respondent's hometown and for the proportion of restaurants statewide that are subject to ordinances. Because the analysis controlled for individual and household characteristics, secular trends, and town-level characteristics, there is strong reason to believe that the estimated effects result from the ordinances rather than reflecting the confounding effects of other factors.

The length of time an ordinance had been in effect was not significantly related to reported exposure. This was somewhat surprising, as we had hypothesized that, even if ordinances were fully implemented immediately upon enactment, consumer perceptions of the change might lag. It is possible that restaurants and their patrons react very quickly to new ordinances, so that exposure rapidly reaches a steady post-ordinance level. It is also possible that, because of the strong general downward trend in exposure, the model is unable to distinguish a time effect related specifically to ordinances.

MTCP funding for a town's board of health has previously been shown to predict adoption of ordinances. Our results show that MTCP funding is also associated with reported ETS exposure levels in restaurants, independent of whether the town passes a restaurant ordinance. This may simply indicate that the towns that sought and received MTCP funding had lower exposure even before they passed ordinances. It is also possible that, given funding, the local boards of health raise public understanding of environmental tobacco smoke, leading restaurants and/or patrons to behavior changes that reduce ETS exposure.

The results also provide information about what kinds of people are most likely to be exposed to ETS when they eat out. Some of the patterns are fairly obvious. Smokers are more likely to be exposed than non-smokers, presumably because they choose restaurants where they can smoke. People who eat out often are likely to report more exposure than those who seldom eat out.

The patterns for demographic variables are perhaps less predictable. Younger people were more likely to report exposure than older people, controlling for other factors, and Non-Hispanic Whites were more likely to report exposure than racial/ethnic minorities. Education was not significantly related to reported ETS exposure, although one might have expected more educated people to be more likely to avoid exposure. Gender, like education, was unrelated to reported exposure.

The results also indicate a strong general time trend, with reported exposure in restaurants declining over the 1993-2000 period. This effect is independent of the adoption of ordinances. It presumably stems in part from general reductions in smoking prevalence and intensity. It may also reflect a secondary effect of restaurant and other smoking restrictions, in which smokers' expectations and behaviors change in ways that reduce the likelihood that they expose other people to ETS.

Three limitations of the analysis should be noted. First, ETS exposure is self-reported and the ordinal nature of the measure makes it relatively imprecise. Although previous research does indicate that reported exposure is correlated with actual exposure, more objective measures of exposure would be useful in estimating the public health benefit of ordinance adoption. Secondly, although we used a simple dichotomous measure indicating the presence of any smoking restriction in restaurants, more stringent ordinances would be expected to have greater effects than less stringent ones. It would be useful for future research to employ more sensitive measures, both to increase the precision with which the effect is measured and to understand better the effects of different types of restrictions. Finally, the measure of ordinance coverage outside the hometown must be considered quite crude because it does not take distance into account. To a resident of Western Massachusetts, an ordinance in Springfield is more relevant than an ordinance in Boston, but Boston has more restaurants, and therefore a greater weight in the measure used. Incorporating distance into the measure would yield a more precise estimate of the ordinance effect.

Endnotes

[1] Brownson R, Eriksen M, Davis R, & Warner K. Environmental Tobacco Smoke: Health Effects and Policies to Reduce Exposure. *Annual Review Public Health*. 1997;18:163-185.

[2] Zeise L, Dunn A, Haroun L, Ting D, Windham G, Golub M, Waller K, Lipsett M, Shusterman D, Mann J, Wu A. *Health Effects of Exposure to Environmental Tobacco Smoke.* California Environmental Protection Agency. 1997.

[3] Davis R (Editorial). *Journal of American Medical Association.* 1998;280(22):1947-1949.

[4] US Centers for Disease Control and Prevention. Discomfort from ETS Among Employees at Worksites with Minimal Smoking Restrictions – United States 1988. *MMWR* 1992;41(20):351-354.

[5] Jones S, Love C, Thomson G, Green R, Howden-Chapman P. Second-hand smoke ate work: the exposure, perceptions and attitudes of bar and restaurant workers to environmental tobacco smoke. *Australia New Zealand Journal of Public Health*. 2001;25(1):90-93.

[6] Thompson B, Emmons K, Abrams D, Ockene J, & Feng Z. ETS Exposure in the Workplace. *Journal of Occupational Medicine.* 1995;37(9): 1086-1093.

[7] Invernizzi G *et al.* Real time measurement of indoor particulate matter originating from environmental tobacco smoke. *Epidemiology Preview*. 2002;26(1):30-34.

[8] Eisner M., Smith A., Blanc P. Bartenders Respiratory Health After Establishment of Smoke-Free Bars and Taverns. *Journal of American Medicine.* 1998;280(22):1909-1914.

[9] Lambert WE, Samet JM, Spengler JD. Environmental tobacco smoke concentrations in no-smoking and smoking sections of restaurants. *American Journal of Public Health*. 1993;83(9):1339-1341.

[10] Siegel, M. Involuntary smoking in the restaurant workplace: A review of employee exposure and health effects. *Journal of American Medicine*. 1993;270(4):490-493.

[11] Biener L, Fitzgerald G. Smoky bars and restaurants: who avoids them and why? *Journal of Public Health Management Practice.* 1999;5(1):74-78.

[12] Brooks DR, Mucci LA. Support for smoke-free restaurants among Massachusetts adults, 1992-1999. *American Journal of Public Health*. 2001;91(2):300-303.

[13] California Tobacco Control Update. California Department of Health Services/Tobacco Control Section, August 2000, 6. (Data are taken from California Adult Tobacco Survey (CATS) 1998, weighted to the 1990 California population using four race and two age groups.)

[14] State Tobacco Activities Tracking and Evaluation (STATE) system, Office on Smoking and Health, Center for Disease Control and Prevention. Available at http://www2.cdc.gov/nccdphp/osh/state/. Accessed August 1, 2002.

[15] Bartosch WJ, Pope GC. Local Enactment of Tobacco Control Policies in Massachusetts. *Am J Public Health* 2002 92: 941-943.

[16] Hamilton W, Weintraub J, Norton G. *Independent Evaluation of the Massachusetts Tobacco Control Program: Seventh Annual Report.* Cambridge, MA. Abt Associates Inc.. 2002.

[17] Massachusetts Tobacco Control Program Ordinance Tracking System (MTCP-OTS), Massachusetts Department of Health.

[18] Eisner M., Smith A., & Blanc P. Bartenders' Respiratory Health After Establishment of Smoke-Free bars and Taverns. *Journal of American Medicine.* 1998;280(22):1909-1914.